Disaster Resilience and the Babel of Semantic

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Abstract

The need for a clear, honest and correct information in emergency and hazards matters is crucial and increasingly complex. The Internet and the web 2.0 have augmented the information and data availability, however the post-Gutenberg age arises some critical points, such as easy access to information, precision and reliability, that are at the center of the current debate. A "Natural Hazard Wiki" (NHW) is here proposed as a "matrix" of a model to be used in "practice". Through the power of «Linked Data», NHW approach could contribute to the development of a natural hazard web semantic in a disaster resilience perspective: retrieving data and developing inferences to increase a better natural hazards and disaster context-awareness.

1 Information in Face of Natural Disasters

Information in science communication is the ability and the capacity to transfer scientific or technical knowledge so to allow the understanding of the content of the communication. Particularly in hazards and emergency matters, a clear, honest and correct information, as stated in many documents and programs (e.g. UNISDR), is crucial to cope with disaster and allow, either practitioners or population to take decision. Knowledge and understanding are a key also to improve disaster risk reduction, climate change adaptation, social protection, either it is a minor or major disaster. The challenge we are facing, a high level of collaboration and interaction: scientists, practitioners, governments, citizens and media. Collaboration between people from different fields and backgrounds could be supported by the new wave of the web: the web of linked data. "Extending the current Web infrastructure to provide mechanisms that make the social properties of information sharing explicit and that guarantee that the uses of this information conform to the relevant social policy expectations of the users."[1] In this perspective, supporting the wide spread of semantic web in the natural hazards and emergency management could be one of the challenge, not to solve problems, neither to find the truth, but to support complex analysis (situational awareness and scenarios), sciences communication and "Precision Journalism", and to ensure knowledge sharing so to be better prepared and resilient in face of natural disasters. International organizations and governments are adopting measures in order to reduce vulnerability of human society, reframed in the context of Disaster Resilience[2] [DR], defined by Intergovernmental Panel on Climate Change as "The ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change". In the field of NH, when the DR perspective considers hazards as exogenous events, "[t]he pond-ecosystem analogy brings another danger by suggesting a clearly defined and bordered system, with external threats ('natural' hazards)

1 Hendler, J., & Berners-Lee, T. (2010). From the Semantic Web to social machines: A research challenge for AI on the World Wide Web. *Artificial Intelligence*, *174*(2), 156–161. doi:10.1016/j.artint.2009.11.010

2 We would underline that there are several and important differences between natural disasters and humanitarian crisis. In this paper we will consider only the Natural Hazards perspective.

and internally determined 'community' resilience. [...][3]. This division, when focusing on natural disasters, ease the burden of responsibility of anthropic interventions that increase the vulnerability. Whilst perceiving natural disasters as natural phenomena, as part of the life of the planet (endogenous), the vulnerability, and then the fragility of societies, strengthen the relationship between social systems and land. In the well known risk equation R=HxVxE, Risk is a function of the probability that a certain event will happen (hazard) and of its potential impact in terms of vulnerability and exposure where vulnerability (V) and exposure (E) are determined by human society. However, the disaster is a cycle that includes "pre-disaster" phases, where preparedness and DR could be seen as an adequate capability to react to a critical event that could reduce the overall risk R=(HxVxE)/DR[4]. This brings to consider DR as linked and expressed in relation to vulnerability or defined by the adaptation capacity through proactive and responsible behaviors. As highlighted by David M. Simpson and Matin Katirai[5], a DR index (DRi) should be the result of Preparedness Index (Pi) and Vulnerability (V) of a specific community/territory. This index considers both Vulnerability and Preparedness has the result of a set of indicators related to the community. This leads to DR as an overall model to better cope with risks, and centered in the "local" dimension" [P. Meier]. Hence, DR requires a *knowledge framework* and a learning system either to perform ''an intrinsic ability of a system, an element or a community to resist the impact of a natural or social event''[6] or "a resilient system or population (that) is not sensitive to climate variability and change and has the capacity to adapt'' [IPCC Third Assessment Report (2001)]. Following the National Strategy for Disaster Resilience of the Australian Government[7], *knowledge and understanding* of hazards (either local knowledge and knowledge of systems, bodies, communities, individuals) can underpin a disaster resilient community. A Natural Hazard Disaster Resilience [NHDR] perspective that considers natural phenomena as "endogenous" strengthen the effect of human intervention and interaction with the territory, far both from the idea of mastering and controlling nature [Horkheimer, Adorno] and the «bon sauvage» naivety. The acceptance of natural hazard is the acceptance there is not a "world disaster free", but that there are actions to be "ready in face of disasters" (resilience). In this perspective a "open and shared knowledge" approach embodies the purpose of people-centred early warning systems, as outlined by the Third International Conference on Early Warning, that could also improve the efficacy and the efficiency of the operational teams and bodies.

1.1 NHDR: the Need of Information

The web era frees the information, and we as individuals are getting accustomed to search on the web to make any kind of decision or to express our opinion. However the internet "information deluge", a continuous and rather chaotic flow, could be represented as an endless library with no filtering function, a true and false endless continuum. This brings to the idea of "encyclopedia" (and of Wikipedia) as a tool to "organize, control and filter"[8] knowledge, to allow communication, knowledge transfer, education, and sense-making. Social media and crowdsourcing[9] have considerable promise for supporting collaborative and innovative ways that reshape the information production and distribution, however now the debate is facing an important concerns related to true-false issues,

3 HPG Policy Brief 49 The relevance of ' resilience '?

4 cfr. Unisdr - Make your city resilient

5 David M. Simpson and Matin Katirai, Indicator Issues and Proposed Framework for a Disaster Preparedness Index (DPi), Center for Hazards Research and Policy Development, Working Paper 06-03

6 Villagran De Leon JC (2006) Vulnerability. A conceptual and methodological review. Publication Series of UNU-EHS. n.4/2006 quoted in Sapountzaki, K. (2011). Vulnerability management by means of resilience. Natural Hazards, 60(3), 1267–1285. doi:10.1007/s11069-011-9908-3

7 http://www.emergency.qld.gov.au/publications/pdf/national_strategy_disaster_resilience.pdf

8 Interview with Umberto Eco, by Paolo Perazzolo - Famiglia Cristiana 22/08/2012

9 Harvard Humanitarian Initiative. Disaster Relief 2.0: The Future of Information Sharing in Humanitarian Emergencies. Washington, D.C. and Berkshire, UK: UN Foundation & Vodafone Foundation Technology Part- nership, 2011.

focusing on validation, and liability. Without any doubt the massive use of Social Media during recent major and minor disasters highlighted a huge need of clear, correct, free and trustworthy information. Hence the challenge is to find models and tools to build an open and structured knowledge and a common understanding in DR to observe natural phenomena, understand natural hazards dynamics and local risks, improve and facilitate the access to validated and reliable information, capacity building to react and to take the right decision in order to cope with and reduce the impact of disaster.

1.2 NHDR as Open Knowledge

The "wealth of networks" allows a better access to information and improve its spreading at low production and distribution costs. This revolutionary change is also shaping knowledge sharing models. «Information as open commons» represents a great opportunity also in DR, where validated scientific information on natural hazards, far from being a common heritage, requires both a high degree of cooperation and a wide interdisciplinary approach. It involves and should commit not only experts, scientists, practitioners, civil servants, but also citizens, volunteers and media representatives. It is based on knowledge, information, skills and competencies (abilities) pertaining to various field such as: scientific, legal, logistics, historical, organizational, psychological, sociological, cultural, health. A complexity that when not taken into account can lead to misleading or «unsafe» information spreading. Couldn't it be a risk to left this information vulnerability only to the spontaneous "crowd" validation? DR should need a multiplayer network where each "node" needs a large and consistent stack of information in order to act and manage all along the disaster cycle: from preparedness to disaster reduction. As a matter of fact, nowadays academics, experts, institutions are called to take the responsibility for a more effective knowledge transfer and exchange (technical, operational, historical, social), abandoning "Elites Knowledge" in favour of a new commitment with the «open age», so to allow the switch from «protection/passivity» (focused on disaster event) to resilience.

2 NHDR Semantics

What can we do in face of the huge amount of information needed and offered on the web? How to make a selection, improve (easy and usable) the searchability and access to information? How to organize individuals and society learning process? How to build a "common language"? The web information "flood" seems to be «a treasure without a map». Democratization of the «quest», freedom of access and usage of information is the challenge of our cultural and societal development, changing how we produce, consume and interconnect information. In this perspective a *context-aware solution*[10] [Hendler, Jim - Berners-Lee, Tim] could be a model also for situational awareness in DR. The effort in the field of Semantic Web and Linked Data could be to draw the «map» and enhance the ability to create infinite roads and tracks in the world wide web. Either we call it Semantic Web, Linked Data, web of things or web 3.0, the overall aim is to improve the sense of direction in the current chaotic mass of contents, with the help of social machines. We envisage the development of a true and concrete Linked Data for DR[11] to build a common language and a common understanding of this domain so to avoid misleading and inappropriate information, and increase preparedness. Ontologies describe and represent areas of concepts, allow the integration of data and are a way to represent knowledge in a domain; metadata allow the semantic interoperability and evaluation of data sources in terms of reliability and trustworthiness. From this perspective metadata and ontologies are

10 Hendler, J., & Berners-Lee, T. (2010). From the Semantic Web to social machines: A research challenge for AI on the World Wide Web. Artificial Intelligence, 174(2), 156–161. doi:10.1016/j.artint.2009.11.010

11 cfr. Minu Kumar Limbu, Integration of crowdsourced Information with Traditional Crisis and Disaster Management Information using Linked Data, http://goo.gl/dWksK

the first building block to build a semantic ecosystem for DR and *par consequénce* for civil protection and emergency management. It is needed to start back from «words», from their meaning and terms relations. The confusion and misunderstanding on natural disaster terms is well widespread and often underestimated in its consequences. For example: risks and hazard, in the common language, are often used as synonyms; or the exact meaning of forecasting that varies depending on hazards[12]. A clear NHDR semantic means to be committed in a «resilient knowledge» perspective, able to open the scientific and experts knowledge to «explanation» and «understanding», so to build a wider awareness, key to make the best decision when facing a disaster. If in some ways technical and scientific knowledges have a sort of "contextual-interoperability", risk management and operational activities are strictly linked to the semantic domains referred e.g to regulations, political and cultural differences; this means that there is a need to expose exact and precise relations between terms pertaining to a wide range of domains.

2.1 DR and terminological tools

The need for a correct and precise vocabulary in DR is an easily understandable issue, whilst not easy to implement. Terminology could be a source of ambiguity and terminology associated with identifying and communicating risk is a relatively new science (F.M. Christensen et al. 2003). On the other hand during emergencies is crucial to understand each other on the base of a common terminology ground where terms and associated concepts should be both comprehensive and unambiguous. Terminological tools could help in the task of sharing a common specific language. The most suitable tools for DR terminology domain are: **Lexicons** - *a list of terms relating to a particular subject* -, **Glossaries** - *alphabetical lists of terms peculiar to a field of knowledge with definitions and explanations* - and **Thesauri** - *structured controlled vocabularies, covering the terminology of a specific knowledge domain* -. Some examples of terminological resources on risk and disaster management are listed.

DPC Glossary: The glossary of Italian Civil Protection Department with about 260 terms on risks and emergency management. http://goo.gl/vAMlw
Australian Emergency Management Glossary - EMA: The EMA glossary provides a list of emergency management terms and definitions (about 1800 terms).
UNISDR terminology: A glossary providing basic definitions on disaster risk reduction (about 54 terms in 6 different languages).
IPCC Glossary: terms used in the Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)
WADEM Glossary: The glossary on risk and disaster management of the World World Association for Disaster and Emergency Medicine. Contains about 200 terms.
Hyperispro: HyperIspro is a wiki (media wiki platform) on civil protection and civil defence focused on the national italian framework.
EARTh Thesaurus (CNR-IIA): EARTh is a bilingual thesaurus (En-Ita) containing more than 15.000 environmental terms, including terms on natural and technological risk.
GEMET (EEA): more than 4000 terms in the environmental domain in 32 languages (EU languages)
Management of a Crisis Vocabulary (MOAC) http://observedchange.com/moac/ns/
SWEET NASA Ontology: Semantic Web for Earth and Environmental Terminology; http://sweet.jpl.nasa.gov/sweet/
Risk Ontology Monitor: http://goo.gl/p7QaC

12 e.g. Forecasting is an issue related to probability, and in some ways it is biased in our rational approach to s*ense making* that does not allow us to accept uncertainty. Stahl, B. C. (2005). The obituary as bricolage: the Mann Gulch disaster and the problem of heroic rationality. European Journal of Information Systems, 14(5), 487–491. doi:10.1057/palgrave.ejis.3000560

2.2 Natural Hazards Wikisaurus

By considering these facts a joint team UNITO-EarthScience and CNR IIA conceived a web project (in the framework of a phD program) "Natural Hazards Wikisaurus" [NHW] to combine two previous experiences: "HyperIspro" and "Earth Thesaurus". The project has the aim to implement an augmented «ontology» conceived as a collaborative virtual source of validated information and knowledge on Natural Hazards and Civil Protection, to sustain and support a common understanding.

HyperIspro: The wiki HyperIspro was developed in 2006[13], following the idea of Giuseppe Zamberletti - former minister of the Italian Civil Protection and president of ISPRO -, aimed at creating a knowledge based web space to spread validated information in the domain of national civil protection and civil defense. It was the first civil protection project with a web 2.0 approach: to encourage sharing and collaboration amongst the experts and practitioners. As Civil Protection and Civil Defense issues are extremely sensitive, entries were moderated by the ISPRO scientific team.

EARTh: The thesaurus model approach proposed for EARTh combines the search of stable logical and conceptual basis with an applicative flexibility. EARTh is based on a multidimensional classificatory and semantic model. It's basically mono-hierarchical and it has been developed according to a tree semantic model. The EARTh terminological content is derived from various multilingual and monolingual sources of controlled environmental terminology.

2.3 The WikiSaurus Framework

The challenge of the WikiSaurus project is threefold:

- **cultural**: setting up a collaboration network committed with Open Knowledge (and data)
- **conceptual**: defining an ontology (thesaurus) related to NHDR
- **technological**: set up a semantic web environment to allow data retrieval from selected sources and sustainable in the long term (easy to maintain technically)

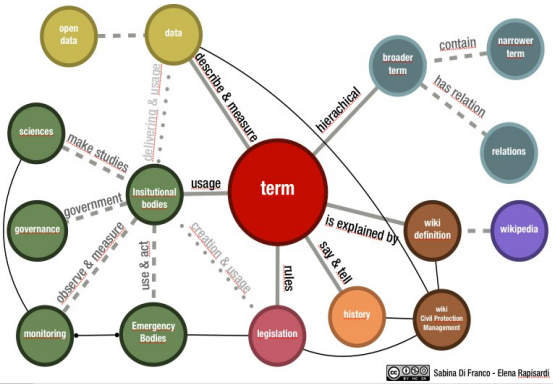

Figure 1: WikiSaurus Web Semantic

As experienced with the HyperIspro wiki, NHDR Information need a high "precision" level. Experience like dbpedia or other retrieval mechanism from crowdsourced knowledge base, although could represent a relevant source, in some cases can not constitute neither the core nor the starting point of a NHDR semantic, due to a crucial issue of validation and reliability of the «data». Lots of information and data are already available on the web, but there are still lacks in this field such as the usage of standards (e.g. for EU the INSPIRE directive) that is not homogeneous across the countries, and within each country. In some ways the state of the art seems more similar to a "bazar" rather than an organized and structured data infrastructure. Moreover, we noticed that there is a bias between information at macro and micro level. Local shared

13 Project Team of HyperIspro: L. Alessandrini - DPC, E. Rapisardi - Formez consultant, A. Molinari - web developer

and open “precise information” is still a huge challenge, and this is particularly important as the impact of natural disasters is at local level. Making data available through linked data, could partially overcome the macro and local bias and would allow to organize in a coherent system (ontologies) the “bazaar” of reliable, validated information on NHDR.

2.4 NHW: State of the Art

The first step has been to give continuity and innovate HyperIspro project, powering the wiki with semantic extensions to publish content via the Semantic Web, and export in RDF format. The review and update of the terms, and of the overall wiki content, is ongoing and will be accomplished through a collaborative approach involving the UNITO-EarthScience Department, CNR IIA and other institutions and bodies concerned in the DR domain.
SW specifications: MediaWiki, Semantic MediaWiki extensions
Beta version: http://goo.gl/LTRbA

The next step will set up the NHW Thesaurus with the following characteristics[14]: Open Source platform; Standards compliant (RDF, SPARQL, OWL, and SKOS); Compliant with W3C guidelines “Cool URIs for the Semantic Web” and “How to publish Linked Data on the Web”; Customizable editing role and permissions; Human interface design approach; integration with other web systems or platforms; multilingual (at least english and italian).
The Thesaurus will help to define the ontologies (Italian and English) to be used as the categories trees of the wiki. This step should also implement the specifications and descriptions of the terms relations as showed in the WikiSaurus Semantic Map. (Figure 1)

Further steps: SW review and selection aimed at finding solutions to integrate the two tools and to build a knowledge-based ontology service.

3 Conclusions

NHW is a tool in the stream of research of data (information) interoperability and collaboration at cultural, technical, semantic and operational level in the field of NHDR. Its aims is to become a point of reference and to break down barriers (language and knowledge,) between practitioners, academics, and citizens, civil servants, media representatives, and students; but it would also represent an open space to comment and contribute to the scientifically validated content. Following the state of the art on risk ontologies, NHW would draw the “matrix” of a model to be used in “practice” and a first step, for a further challenging program. Through the power of «linked data», NHW approach could contribute to the development of a natural hazard web semantic in a disaster resilience perspective: retrieving data and developing inferences to increase a better NH and disaster context-awareness.

14 e.g. - http://www.vocabularyserver.com/ http://sourceforge.net/projects/tematres/ that has also a wordpress plugin to include a tematres vocabulary, taxonomies, thesauri in a wordpress deployement; http://iqvoc.net; Protegé

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